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Taxes, the Cost of Capital, and Investment: A Comparison of Canada and the United States

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WORKING PAPER 97-3

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Abstract

In this paper, we present historical data pertaining to the cost of capital and investment spending in Canada and the United States. We also perform an empirical analysis of the impact of changes in the relative cost of capital on relative investment levels in the two countries. A comparison between the Canadian and U.S. experiences is useful, because the two countries face many of the same market conditions. By comparing the two countries, we are able to control for shocks that are common to both.

Two main conclusions can be drawn from this paper. First, the user cost of capital has generally been higher in Canada than in the United States throughout the period 1971-96. This is primarily due to higher real interest rates in Canada, although the tax system has also contributed to Canada's higher cost of capital. Second, we find evidence that changes in the relative cost of capital have had a small, but statistically significant, impact on relative investment levels in the two countries for equipment investment, although not for structures investment.

Table of Contents

1. Introduction

An understanding of the relationship between tax instruments and investment spending is essential for the formulation of tax policy. According to modern investment theory, taxes have the potential to affect investment spending through their impact on the cost of capital. In this paper, we present historical data pertaining to the cost of capital and investment spending in Canada and the United States. We also perform some statistical analysis of the impact of changes in the relative cost of capital on relative investment levels in the two countries. Our hope is that the paper will provide useful background material for policy discussions and motivate further empirical studies in a Canadian context.

A comparison between the Canadian and U.S. experiences is useful, because the two countries face many of the same market conditions. Therefore, firm investment decisions, which are based in part upon expectations, are likely to be a function of some of the same (perhaps unobservable) factors. By comparing the two countries, we are able to control for shocks that are common to both. Differences between investment behaviour in the two countries can be attributed to country-specific factors that affect current and expected future productivity and costs of capital. Such factors would include tax policy and interest rates, among many others.

2. The Cost of Capital in Canada and the United States

In this section, we introduce the notion of the cost of capital and compare cost-of-capital estimates across sectors and over time for the two countries. Neoclassical investment theory predicts that a profit-maximizing firm will accumulate capital up to the point where the marginal revenue from a unit of capital is just equal to the cost of employing that unit. Under certain conditions, it can be shown that the optimizing condition can be written as:[1]

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[1] For a formal derivation, see Boadway (1987). See also, McKenzie and Mintz (1992).

$$F_K(K) = C \equiv q(r_f + \delta - \pi)\frac{(1 - \phi - u(1 - f\phi)A)}{(1 - u)} \tag{1}$$

where

$F_K(K)$ = the marginal product of capital;

C = cost of capital;

q = price of a unit of capital relative to output;

u = corporate income tax rate;

r_f = $i(1-u)\beta+\rho(1-\beta)$

= the weighted average nominal after-tax opportunity cost of finance, where i is the nominal interest rate on debt, β is the debt/asset ratio, and ρ is the opportunity cost of equity finance;

δ = the economic depreciation rate on capital;

π = the inflation rate;

ϕ = the Investment Tax Credit (ITC) rate;

f = the portion of the ITC that reduces the tax-depreciation base; and

A = the present value of tax depreciation deductions on $1 of capital;

The right-hand side of this equation is the cost of capital, denoted by C. According to neoclassical investment theory, anything that increases C will tend to lower capital accumulation, and anything that decreases it will tend to increase capital accumulation. Ignoring the tax terms for a moment, the cost of capital consists of the weighted average of the forgone real rate of return on the funds invested in a unit of capital, $q(r_i - \pi)$, plus the economic depreciation on that

unit, $q\delta$. The tax system impacts the cost of capital in several ways. First, by taxing the revenue stream generated by an incremental unit of capital, the marginal product of capital declines by a factor of (1-u). This is akin to an increase in the cost of capital by the factor 1/(1-u). This, in and of itself, tends to discourage investment.

The tax system also allows various deductions and credits that reduce the cost of capital, and therefore tend to encourage investment. First, debt interest is allowed as a deduction for tax purposes, which lowers the opportunity cost of finance, r_f. Second, Investment Tax Credits (ITCs), granted as a percentage of the purchase price of capital, lower the cost of capital by reducing the effective after-tax purchase price of a unit of capital by $q\phi$. Third, the purchase price of a unit of capital is also reduced by tax-depreciation allowances that are claimed over time. The present value of those deductions is denoted by qA; the reduction in taxes is therefore quA. The value of the tax-depreciation deductions may or may not be reduced by the amount of the ITC claimed. This is captured by the parameter f. In Canada, the tax-depreciation base is reduced by the full amount of the ITC. Thus, f=1, and the present value of the tax-depreciation deductions is $qu(1-\phi)A$. In the United States, currently f=0, and there is no reduction in the tax-depreciation base due to the ITC – i.e. the present value of the tax-depreciation deductions is quA. At various times in the past, however, the base has been reduced by one half of the ITC claim, in which case f=.5. The ITC and tax-depreciation allowances reduce the after-tax price of a unit of capital to $q(1-\phi -u(1-f\phi)A)$.

As indicated, under neoclassical investment theory, changes in the cost of capital, C, are expected to give rise to changes in investment. The cost of capital may change due to changes in any of the variables on the right-hand side of the expression, be they tax parameters such as u, A, or ϕ, or non-tax variables such as i, ρ, δ, π or q. There are also interactions between the tax and non-tax variables. Before examining the time series of C for Canada and the United States, it is therefore useful to first compare movements in some of the individual terms that make up the cost of capital in the two countries.

2.1 Non-tax Variables[2]

We begin with Figure 1, which illustrates the relative price of capital (q) in the two countries. These data represent index numbers where 1970 values are equal to one for both countries. Therefore, their *levels* cannot be compared. The changes in these price indices, however, do provide information about changes in the cost of capital in the two countries. As seen in the figure, the price of capital relative to output rose in the United States relative to Canada between the mid-1970s and mid-1980s, while it fell for both countries at roughly the same rate in the mid- to late-1980s. Since the early 1990s, the U.S. relative price of capital has continued to fall, while the relative price in Canada has increased somewhat.

Figure 1
Relative Price of Capital

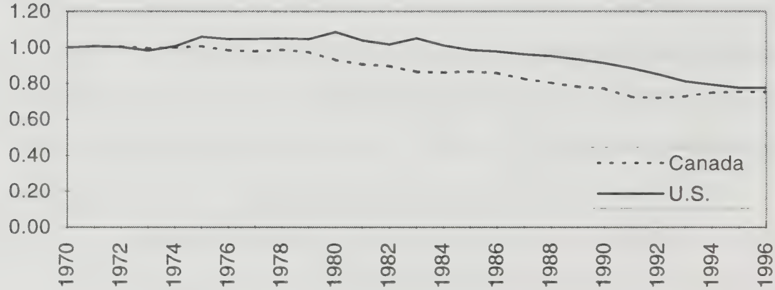

Figure 2 illustrates *ex post* real interest rates in the two countries. The *ex post* real interest rate is the three-month Treasury Bill rate minus actual CPI inflation.[3] It would be more appropriate to use some measure of expected inflation. A consistent time series of expected inflation rates, however, is not available to us for both countries. Because of the use of realized inflation, real interest rates were actually negative during the high-inflation periods in the 1970s.

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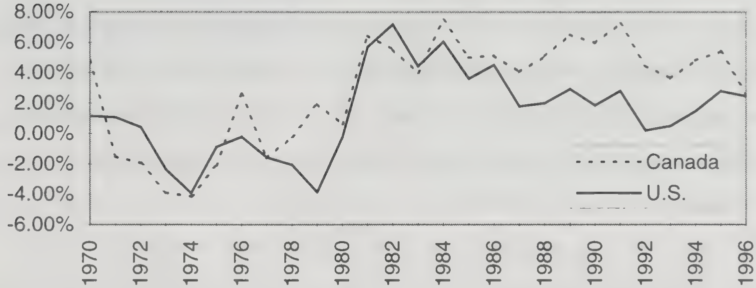
[2] See Table A.1 for a list of the data and sources.

[3] We have also used the yield on 10-year government bonds to measure real interest rates in both countries. Our analysis is similar in both cases. See footnote 7.

Figure 2
Canada-U.S. Real Interest Rates

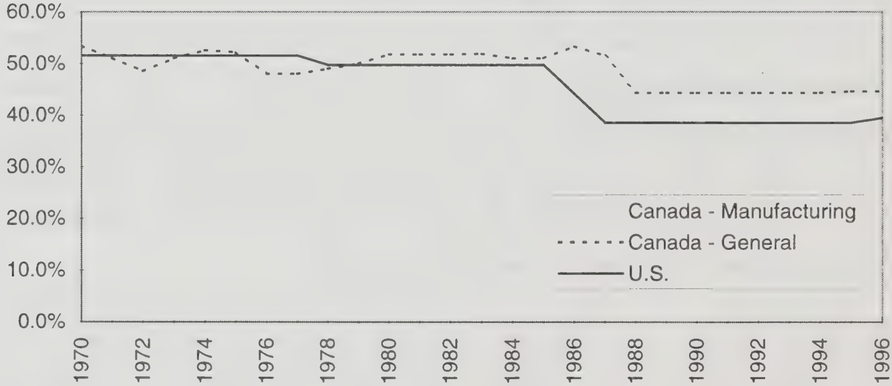


Immediately evident from the figure is the fact that, with a few exceptions in the early and late 1970s, *ex post* real interest rates in Canada have exceeded those in the United States, sometimes substantially so. This is particularly the case from 1984 through 1995, during which time Canadian real rates were consistently higher than U.S. rates. Over the entire sample period, Canadian real interest rates exceeded those in the United States by about 1.5 percentage points on average. Remembering that these are "risk free" *ex post* rates, based upon nominal T-Bill rates, this is indicative of a substantial country-specific interest-rate premium in Canada, which has tended to increase the cost of capital facing Canadian firms. As with the relative price of capital, however, there is evidence of a narrowing in the spreads over the past few years, with virtually identical real interest rates in the two countries in 1995 and 1996.

2.2 Tax Variables[4]

Turning now to some of the tax parameters, Figure 3 shows the combined federal and state/provincial statutory corporate income tax (CIT) rates, u, facing large companies in Canada and the United States. For Canada, both the general and manufacturing CIT rate is shown. The United States does not impose different rates for manufacturing and non-manufacturing. From 1970 to 1985 rates for non-manufacturing firms in the two countries were roughly similar. The U.S. *Tax Reform Act* of 1986, however, decreased the CIT rate by more than 10 percentage points. While Canada followed with rate reductions as a part of its own tax reform in 1987, the reduction in Canada was somewhat less dramatic. As such, during the period following 1985 the non-manufacturing CIT rate in the United States was about 6 percentage points lower than the rate in Canada.

Figure 3
Corporate Tax Rates



We see a slightly different story in the manufacturing sector. In the early period of our data, from 1972-85, the Canadian CIT rate on manufacturing was substantially lower than the U.S. rate. Following the tax reforms in the two countries, the U.S. rate dropped significantly, with the Canadian rate dropping somewhat less. As such, from 1986-90, the U.S. CIT rate on

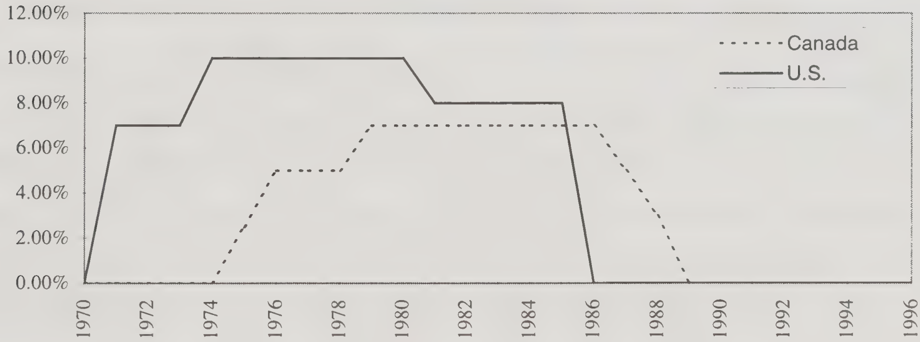
[4] See Table A.2 for a list of the data and sources.

manufacturing was slightly below the Canadian rate. From 1992 on, however, the Canadian manufacturing CIT rate has been slightly lower.

Since increases in CIT rates tend to increase the cost of capital, a comparison of statutory CIT rates suggests that, since 1986, the tax rates in the United States have tended to lower the cost of capital facing non-manufacturing firms relative to their Canadian counterparts, all else being equal of course, while, since 1993, Canadian manufacturing firms have faced a relatively lower cost of capital.

Figure 4 illustrates ITC rates (ϕ) over the 1970-1996 period. We see that the United States has tended to employ somewhat higher ITC rates, although they were eliminated earlier than in Canada. In the United States, a 7-percent general ITC was introduced in 1971, subsequently increased to 10 percent in 1974, reduced to 8 percent as a part of the tax changes in 1981 and then eliminated altogether as a part of the 1986 tax reform. Canada introduced ITCs in 1975, at a 2.5-percent rate. The rate was increased to 5 percent in 1976, then to 7 percent in 1979, where it stayed until ITCs were phased out over a three-year period beginning in 1986.[5] In sum, from 1971 to 1985, ITC rates were higher in the United States than in Canada, and from 1986 to 1988 the rates were slightly higher in Canada as a part of a three-year phase out of ITCs.

Figure 4
ITC Rates



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[5] Currently, an 8% ITC is still available in the Atlantic provinces.

It is important to note that not all investment is eligible for ITCs. In both countries, most investment in machinery and equipment could earn ITCs. Investment in buildings and other structures, however, could not. The exception was some types of investment in structures in the Transportation, Communications and Utilities sectors in the United States, which was eligible for the ITC. For the most part, throughout the period studied, U.S. firms thus enjoyed a lower cost of capital relative to Canadian firms because of a more generous ITC, both in terms of the rate and the scope of coverage.

Figure 5 displays the present value of the tax-depreciation deductions on a $1 investment in the two countries (A). The calculations reflect a weighted average across sectors and asset categories (buildings and equipment). With a few exceptions discussed below, statutory tax write-off rates have not changed very much in either country over the period examined. Therefore, the year-to-year fluctuations in the figure reflect changes in the nominal interest rate, which is used to discount the tax-depreciation deductions.[6]

Figure 5
Present Value of Tax Depreciation on $1

[6] The tax depreciation base is not indexed for inflation in either country. Therefore, the present value of tax-depreciation deductions is determined using the nominal interest rate.

One point that is immediately evident from the graph is that, in present value terms, the tax-depreciation systems in the two countries have been roughly similar. In aggregate, depreciable assets were written off at a slightly faster rate in Canada from 1970 to 1980, generating a slightly higher present-value reduction in the after-tax price of capital, and a concomitant reduction in the cost of capital over this period. However, since 1981, the present value of depreciation deductions has been slightly higher in the United States. This coincides with the introduction of the Accelerated Cost Recovery System (ACRS) in the United States. The ACRS increased write-off rates in the United States across the board, partly to compensate for a concomitant reduction in the ITC rate. The introduction of the ACRS increased the present value of depreciation allowances in 1981 despite a coincident increase in the U.S. nominal interest rate. This rise continued through to 1986, due to reductions in nominal interest rates, when a new tax-depreciation schedule was introduced as part of the 1986 tax reform. The Modified Cost Recovery System (MACRS) reduced write-off rates slightly, while the CIT rate was lowered, and ITCs were eliminated (see above). This change is reflected in Figure 5 as a reduction in the present value of depreciation allowances. In Canada, the tax reform of 1987 also lowered depreciation rates in conjunction with a reduction in the CIT rate. This shows up as a decline in the present value of tax-depreciation deductions in 1987. Minor increases in write-off rates in Canada in the 1990s, particularly in manufacturing, accompanied by lower nominal interest rates, have brought the present value of depreciation allowances very close together in the two countries. Since 1994, they have been virtually identical.

To provide an indication of the net impact of the tax system on the cost of capital in the two countries, we illustrate the $(1-\phi-u(1-f\phi)A)/(1-u)$ component of the cost of capital in Figure 6. While this "tax factor" does not fully isolate the tax effects – the present value of tax-depreciation deductions still changes because of movements in the nominal interest rate, and the component does not incorporate the deductibility of debt interest – it does capture some of the interaction between ITCs, the CIT rate and the depreciation deductions.

Figure 6
Tax Factors

Although there is some year-to-year variation due to changes in nominal interest rates, some of the key tax initiatives undertaken by the two countries are reflected in the figure. With respect to U.S. tax changes, the introduction of the ITC in the Unites States in 1971 lowered the tax component of the cost of capital substantially. The combined introduction of ACRS and reduction in the ITC in 1981 had the net effect of decreasing the tax factor as well. Finally, the U.S. tax reform in 1986, which eliminated the ITC and lowered tax-depreciation rates, but reduced the CIT rate, had the net effect of increasing the tax factor. For Canada, we also see the impact of the introduction of the ITC from 1974 to 1976, as the tax factor fell over that period. We also note that the Canadian tax reform of 1987, reducing ITCs, lowering write-off rates and reducing the CIT rate, had a fairly neutral effect on the tax component of the cost of capital.

The figure emphasizes that on balance, the tax factor has been higher in Canada than in the United States over the period studied, sometimes substantially so. From the mid-1970s through 1995, the Canadian tax factor was consistently above the U.S. factor, with a particularly large differential in the mid-1980s. This, of course, suggests that the tax system in Canada has tended to increase the cost of capital more than the tax system in the United States.

2.3 Estimates of the Cost of Capital

Figures 7 and 8 illustrate our estimates of the cost of capital for the eight sectors for which the necessary data were available for both Canada and the United States.[7] Note first that in each country the series for all of the sectors tend to move together. This is not surprising given the common components of the cost of capital, particularly interest and inflation rates, and, to a lesser extent, some of the tax parameters. The construction sector in both countries faces a substantially higher cost of capital than the other sectors. Moreover, despite its generous tax treatment, through faster write-off rates, higher ITC rates and lower tax rates (in Canada), the cost of capital in manufacturing is roughly in line with the other sectors in both countries. This is due largely to technological considerations, specifically the useful service lives of the assets utilized in the various sectors. The economic rate of depreciation (δ) on assets used in the manufacturing sector tends to be quite high, despite the fact that investment is about evenly split between equipment and structures. This is also the case in the construction industry, which is very heavily weighted toward faster depreciating equipment. As indicated by the cost of capital equation presented above, a high economic rate of depreciation implies a high cost of capital.

[7] Cost of capital estimates using 10-year bond yields for the interest-rate measure are similar to those illustrated in Figures 7 and 8. The correlations between the cost of capital based on the two different interest-rate measures range from 0.80 (for the Canadian construction industry) to 0.96 (for the U.S. transportation, communications and utilities industry).

Figure 7
Canadian Cost of Capital Estimates

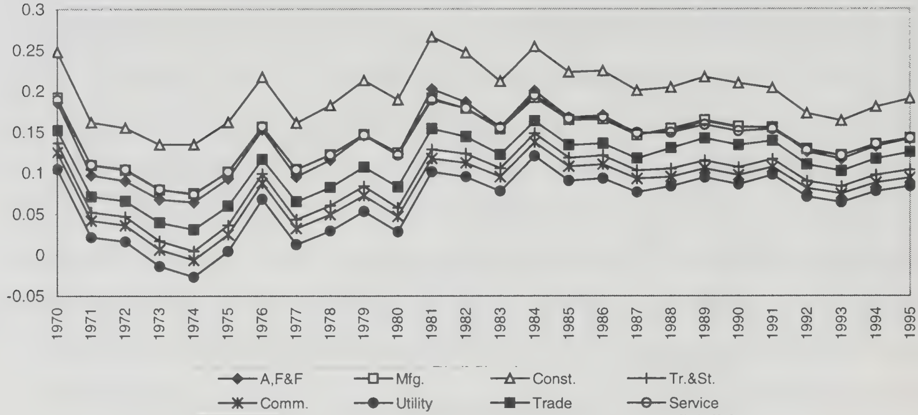
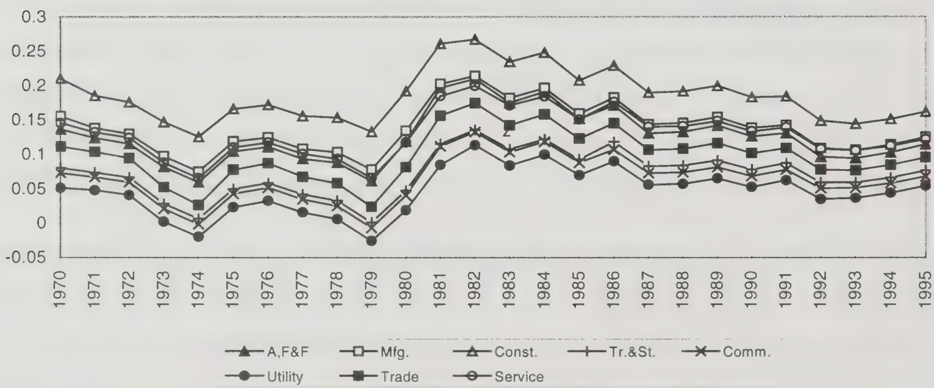


Figure 8
U.S. Cost of Capital Estimates



The figures reveal some of the key changes that were highlighted above. In the United States, there was a sharp increase in the cost of capital in 1981 due to the increase in real interest rates. The same thing occurred in Canada, although on a smaller scale, from 1980 through 1984. As discussed above, the 1986 tax reform in the United States increased the tax component of the cost of capital, but we see that, overall, the cost of capital declined from 1986 to 1987, due to a reduction in real interest rates.

With the above background in hand, we are in a position to compare the cost of capital for Canada and the United States over the period studied. As illustrated in Figure 9, the average cost of capital over the period has been greater in Canada than in the United States for all of the individual sectors that we study. From Figure 10, which illustrates the aggregate cost of capital in the two countries, it is evident that the cost of capital in Canada has tended to be higher than the cost of capital in the United States for much of the sample period, most particularly the mid-to late 1970s and from 1987 to 1995. This suggests that the incentive to invest has been somewhat lower in Canada than in the United States.

Figure 9
Canada and U.S. Cost of Capital - Averages by Sector

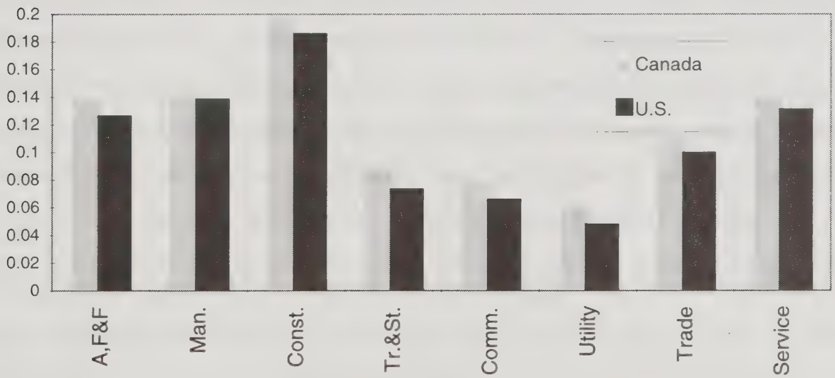
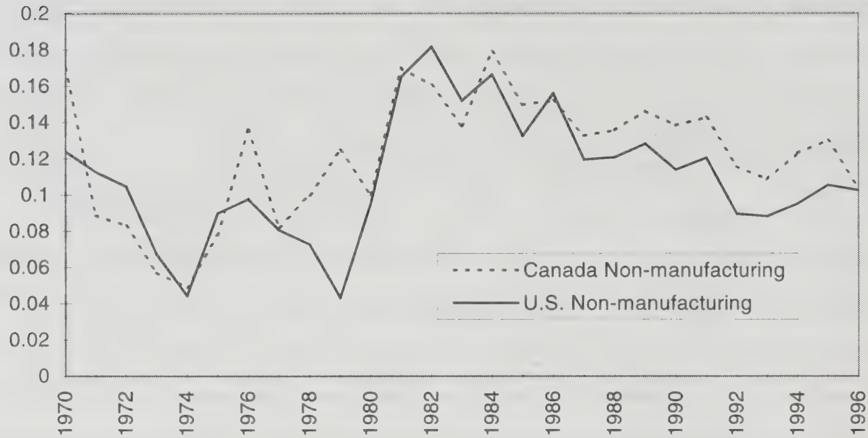


Figure 10
Canada and U.S. Cost of Capital - Aggregate Non-manufacturing



Drawing from our discussion of the components of the cost of capital for each country, it is possible to gain some insights into the primary reasons for the differences between the two countries. From the above discussion, it is evident that virtually every component of the cost of capital, both tax- and non-tax-related, has tended to increase the cost of capital in Canada relative to the United States. Most important in this regard has been the somewhat higher real interest rates in Canada. However, as discussed above, the tax system in Canada, particularly in the non-manufacturing sectors, has also contributed to Canada's higher cost of capital. The relatively generous tax treatment of manufacturing in Canada has offset, to some extent, the U.S. cost-of-capital advantage in this sector.

Importantly, although the U.S. cost-of-capital advantage has been quite pronounced historically, more recently the cost of capital in the two countries has moved much closer together. For the most part, this is due to a convergence in real interest rates, with the historically high spread favouring the U.S. virtually disappearing. Some limited tax changes in Canada have also contributed to a small extent; for example, higher write-off rates in manufacturing and a reduction in the CIT rate on manufacturing.

3. Investment Patterns

Before proceeding to an analysis of the relationship between the relative cost of capital and relative investment levels, it is useful to first describe investment patterns in the two countries. In this section we discuss aggregate investment expressed as a share of gross domestic product (GDP). The data are based on national income accounts and represent investment in fixed non-residential business capital.[8] It should be noted that the Canadian data include business investment by both private and government-owned enterprises, while the U.S. data include only private investment spending. Although Canadian aggregate investment data are available for public and private investment separately, this breakdown is not available for the sector-level data required for the analysis below. Public investment accounted for approximately 22 percent of total business investment during the period 1972-93, and, as seen in Table 1, it is concentrated primarily in the transportation, communications and utilities sector. To the extent that investment by government-owned enterprises is significant in the U.S. business sector (which is unlikely), the data will understate the amount of U.S. business investment. This does not pose a serious problem for our study, however, since we focus on changes in Canadian-U.S. investment differentials over time rather than the actual sizes of the differentials.

A related concern is that government-owned enterprises may have different objectives than privately owned enterprises and thus may not respond to changes in the cost of capital and other factors in the same manner. This suggests that U.S. private investment may not provide an appropriate "control" group for Canadian business investment. As seen in Figure 11, however, total non-residential business investment and private non-residential business investment are highly correlated.[9] Therefore, we feel that the differences over time between these series should provide a reasonable indication of differences in Canadian and U.S. business spending.

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[8] The Canadian data are drawn from the CANSIM database and can be found in Statistics Canada, National Income and Expenditure Accounts. The U.S. data are drawn from the Bureau of Economic Analysis, U.S. Department of Commerce, Selected NIPA Tables diskette.

[9] Private business investment is calculated by adding capital expenditures for private business enterprises and government-owned enterprises based on Table 23 of Private and Public Investment in Canada, 1992. These data do not include adjustments and historical revisions made in the national income accounts.

Figure 11
Canadian Non-Residential Business Investment

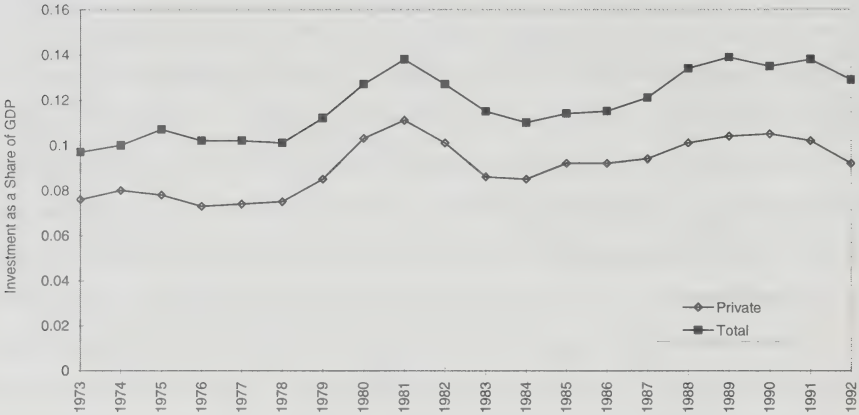


Table 2 provides summary statistics of the data for the period 1970-95 as well as for the sub-periods 1970-80, 1981-89, and 1990-95. The latter two periods were chosen to coincide with the beginnings of the recessions in the 1980s and 1990s, respectively. During the period 1970-95, non-residential business investment in Canada was 11.7 percent of GDP, while in the United States, non-residential private investment was 9.4 percent of GDP, yielding a differential of 2.3 percentage points. As seen in the table, the gap between Canadian and U.S. investment as a share of GDP increased from an average of 1.5 percentage points during the period 1970-80 to an average of 3.9 percentage points during the first half of the 1990s. This increase is due to an increase in Canadian investment in equipment relative to U.S. equipment investment.

Table 1
Share of Public Investment, Canada

Industry	1993
Agriculture and Fishing	...
Logging and Forestry	--
Mining, Quarrying and Oil Well Industries	8.1
Manufacturing	1.1
Construction	...
Transportation and Storage	25.7
Communications and Other Utilities	59.8
Wholesale Trade	--
Retail Trade	2.7
Finance and Insurance	2.6
Real Estate	1.6

Source: Tables 27 and 28 of Private and Public Investment in Canada, Revised Intentions 1994. Data represent preliminary actual capital expenditures.
... = not applicable
-- = too small to be reported

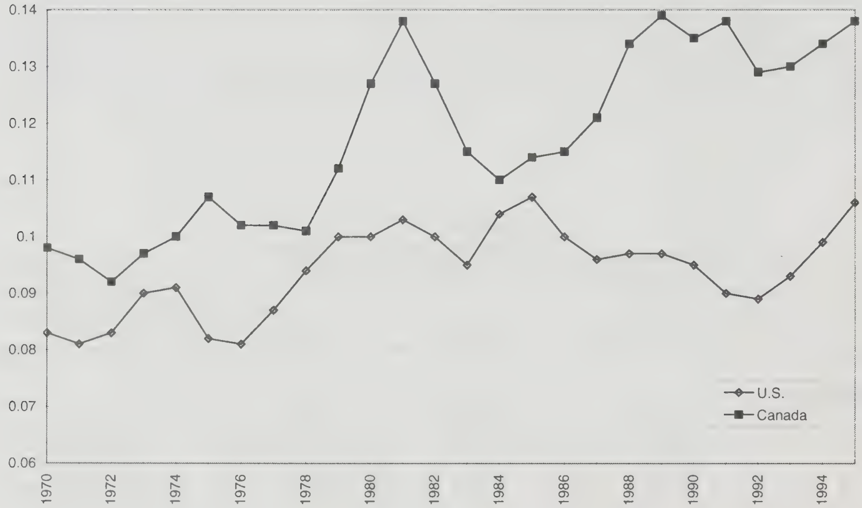
Table 2
Business Investment as a Share of GDP

	1970-95	1970-80	1981-89	1990-95
Total Investment				
Canada	0.117	0.103	0.124	0.134
U.S.	0.094	0.088	0.100	0.095
Canada-U.S.	0.023	0.015	0.024	0.039
Equipment				
Canada	0.061	0.043	0.066	0.086
U.S.	0.058	0.051	0.061	0.067
Canada-U.S.	0.003	-0.008	0.005	0.019
Structures				
Canada	0.056	0.060	0.057	0.048
U.S.	0.036	0.038	0.039	0.028
Canada-U.S.	0.020	0.022	0.018	0.020

Source: Statistics Canada, National Income and Expenditure Accounts BEA, U.S. Department of Commerce, Selected NIPA Tables.

Figure 12 illustrates non-residential business investment as a share of GDP for both countries during the period under consideration. Although there are some marked differences between the two series, particularly during the 1980s, there are also some common movements. The correlation between the series is 0.58 and is statistically significant at the 1-percent level. This correlation reflects, in part, the upward trend apparent for both countries. An interesting feature of the data is that the local peaks of the Canadian-U.S. differential occur during times of recession: 1975, 1981 and 1991. The 1991 peak is preceded by a dramatic increase in 1989.

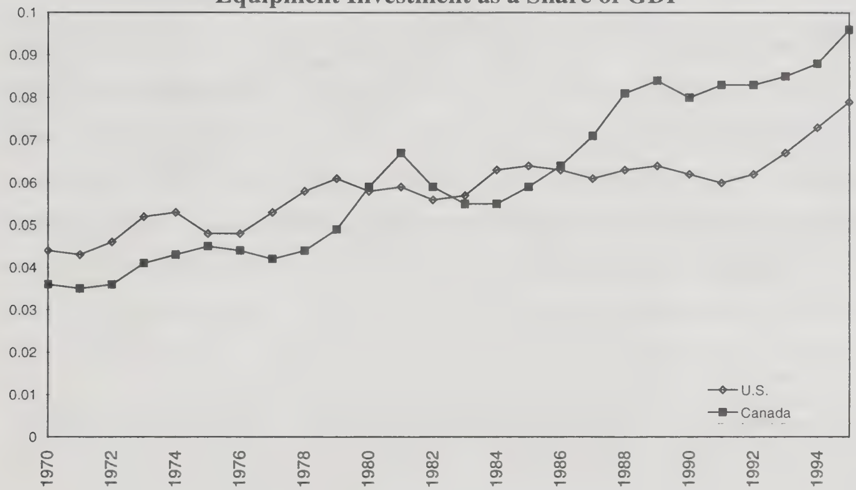
Figure 12
Non-residential Business Investment as a Share of GDP



When the two components of non-residential fixed business investment are examined separately, the relationship between U.S. and Canadian investment is more apparent. The correlations between Canadian and U.S. spending on structures and equipment as a share of GDP are 0.81 and 0.86, respectively. As with total investment, these correlations reflect, in part, common trends. Structures investment fell in both countries over the period, while equipment investment

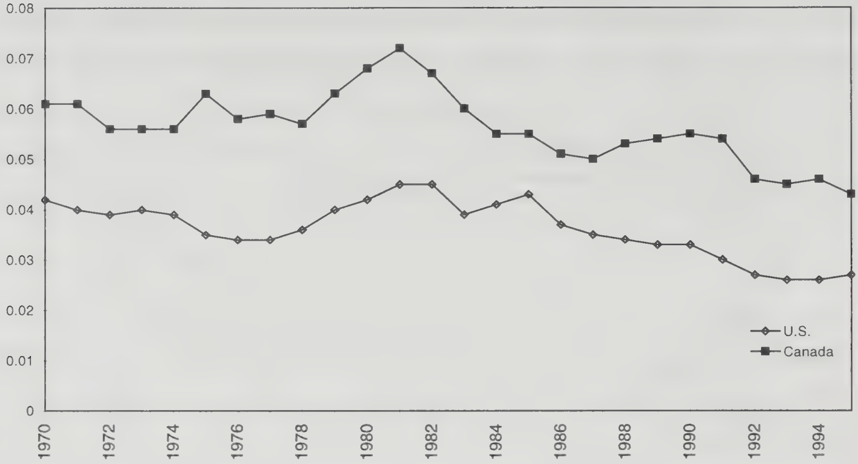
rose in both countries. As seen in Figures 13 and 14, the variation in the Canadian-U.S. investment differential is due primarily to a variation in relative investment in equipment.[10] The differential is relatively constant for structures. Both the structures and equipment differentials peak in 1975, 1981 and 1991, although the peaks are much less pronounced for structures.

Figure 13
Equipment Investment as a Share of GDP



[10] The correlations between the investment differential for total capital expenditures and the differentials for expenditures on structures and on machinery and equipment are 0.38 and 0.94, respectively, for the period 1970-95.

Figure 14
Structures Investment as a Share of GDP



It should be noted that the Canada-U.S. Free Trade Agreement (FTA) was reached in 1987 and implemented in 1989. One of the central Canadian goals of this agreement was to obtain security of access to the U.S. market, and therefore, to create a more predictable investment environment. Thus, it was hypothesized that the FTA might lead to an increase in investment in Canada. The increase in structures investment from 1987 to 1991 is consistent with the hypothesized FTA effect, particularly since U.S. investment was declining during this period. Investment in machinery and equipment also increased during this period, although the increase began in 1985, before the FTA negotiations had seriously begun. This suggests that investment was responding, at least in part, to factors other than the FTA. This is consistent with the stock-market analysis by Thompson (1993), which indicates that there is no strong evidence that the FTA was anticipated to have a significant *net* impact on investment in Canada.[11]

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[11] Stock market responses to news that a free trade agreement had been reached indicate that investors expected free trade to have significant differential impacts on individual manufacturing industries (some positive and some negative), but there is no strong evidence to suggest a significant net impact.

With respect to the relationship between the cost of capital and investment, a few interesting points can be made. First, the most recent increase in the (positive) gap between Canadian and U.S. investment, expressed as a share of GDP, occurred in 1986. This coincides with a period in which the cost of capital in Canada was rising relative to the cost of capital in the United States. All other things being equal, this is inconsistent with the predicted negative relationship between the cost of capital and investment.

This recent gap between Canadian and U.S. investment also coincides with the 1986 U.S. tax reform. As discussed above, this tax reform increased the tax component of the U.S. cost of capital. Earlier data suggest that U.S. investment rose rapidly relative to GNP in 1988.[12] The fact that investment actually increased following the 1986 tax reform has typically been interpreted as shedding doubt on the predicted negative impact of taxes on investment. As discussed above, however, our estimates indicate that the U.S. cost of capital fell following the tax reform due to declining real interest rates. In addition, Figure 12, which is based on the most recently revised estimates of the Bureau of Economic Analysis (BEA), indicates that investment in the United States actually fell in 1987 and then increased only slightly in 1988 and 1989. During this period, Canadian investment increased significantly. This suggests the possibility that other factors increased the incentives to invest for both countries. An example of one such factor is technological change, which increased the demand for investment in computing and office equipment.[13]

4. Relationship Between the Cost of Capital and Investment

4.1 Empirical Approach

Our purpose in this section is to analyse the impact of changes in the cost of capital on investment rates in Canada relative to the United States. To do this, we estimate a variant of the neoclassical investment model. Although there have been many criticisms of this model on

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[12] See, for example, Auerbach and Hassett (1990).

[13] See Auerbach and Hassett (1990) for a discussion of investment in computing equipment during this period.

theoretical grounds, it has tended to perform well empirically relative to more theoretically rigorous models.[14] Our empirical analysis is based on the following version of the neoclassical model:

$$\left(\frac{I_t}{K_{t-1}}\right) = \delta + \sum_{j=0}^{J} \beta_j \left(\frac{\Delta C_{t-j}}{C_{t-j-1}}\right) + \sum_{j=0}^{J} \gamma_j \left(\frac{\Delta Y_{t-j}}{Y_{t-j-1}}\right) + \varepsilon_t, \tag{2}$$

where I/K_{t-1} is the investment rate at time t, δ is the rate of depreciation, C_t is the cost of capital at time t, and Y_t is output at time t.[15] The distributed lag coefficients reflect a combination of expectation parameters, delivery lags and technology parameters.

For our purposes, we are interested in describing the behaviour of Canadian investment rates relative to U.S. rates. Specifying equation (2) for Canada and the United States and subtracting one from the other, we derive:

$$\left(\frac{I_{i,t}}{K_{i,t-1}}\right)^{can-us} = \delta_i^{can} - \delta_i^{us} + \sum_{j=0}^{J} \beta_j \left(\frac{\Delta C_{i,t-j}}{C_{i,t-j-1}}\right)^{can-us} + \sum_{j=0}^{J} \gamma_j \left(\frac{\Delta Y_{i,t-j}}{Y_{i,t-j-1}}\right)^{can-us} + \varepsilon_{it}^{can-us}, \tag{3}$$

where $(I_{it}/K_{i,t-1})^{can-us} = (I_{it}/K_{i,t-1})^{can} - (I_{it}/K_{i,t-1})^{us}$, $(\Delta C_{it}/C_{i,t-1})^{can-us} = (\Delta C_{it}/C_{i,t-1})^{can} - (\Delta C_{it}/C_{i,t-1})^{us}$, and $(\Delta Y_{it}/Y_{i,t-1})^{can-us} = (\Delta Y_{it}/Y_{i,t-1})^{can} - (\Delta Y_{it}/Y_{i,t-1})^{us}$. It should be noted that this derivation assumes that the β and γ coefficients are the same for the two countries. Given the similarities of technology in the two countries, this is not unreasonable. The sum of the β coefficients represents the elasticity of

[14] See Chirinko (1993) for a discussion of the neoclassical investment model as well as alternative models. See also Oliner, Rudebusch and Sichel (1995) for a comparison of the forecasting performance of various models.

[15] See Chirinko and Meyer (1996) for a formal derivation.

the Canadian capital stock relative to the U.S. stock with respect to the relative cost of capital.[16] In other words,

$$\Sigma\beta = \frac{\Delta(K^{can} / K^{us})/(K^{can} / K^{us})}{\Delta(C^{can} / C^{us})/(C^{can} / C^{us})}. \tag{4}$$

The error term of equation (3), $\varepsilon^{can\text{-}us}$, is equal to ε^{can}-ε^{us}. Thus, shocks that are common to the two countries have been subtracted out of the equation.

Equation (3) is estimated for investment in structures and equipment for the five sectors for which consistent data series are available. Two different estimation methods are employed. First, the data are pooled for the five sectors, and a fixed-effects model is estimated. A sector-specific intercept term is employed to allow for potential differences in (δ^{can}-δ^{us}) among sectors as well as any other sector-specific fixed effects. This is equivalent to employing the mean-difference technique, where all variables are expressed in terms of their deviations from sector-specific means (over time). Separate equations are estimated for structures and equipment. To test for potential measurement error, we also employ a first-difference approach for controlling for fixed effects, where all variables are expressed in first-difference form. In the absence of measurement error, these two estimators will be asymptotically equivalent. With measurement error, however, the first-difference approach will yield estimates that are biased toward zero relative to the estimates based on the mean-difference approach.[17]

In addition, a seemingly unrelated regressions (SUR) model is estimated. Under this approach, ten equations – a structures equation and an equipment equation for each of the five sectors – are estimated as a system of seemingly unrelated regressions. To preserve degrees of freedom, the

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[16] Extending the discussion of Chirinko and Meyer (1996) to the specification in equation (3), note that $(I_t/K_{t-1})^{can}$ - $(I_t/K_{t-1})^{us} = \delta^{can} - \delta^{us} + (\Delta K_t/K_{t-1})^{can} - (\Delta K_t/K_{t-1})^{us}$. From (3), this equals $\delta^{can} - \delta^{us} + \Sigma\, \beta\, [(\Delta C_{it}/C_{i,t-1})^{can} - (\Delta C_t/C_{t-1})^{us}]$, holding changes in output constant. Thus, the sum of the β coefficients is equal to $[(\Delta K_t/K_{t-1})^{can} - (\Delta K_t/K_{t-1})^{us}]/[(\Delta C_t/C_{t-1})^{can}$ - $(\Delta C_t/C_{t-1})^{us}]$.

[17] See Griliches and Hausman (1986).

cost-of-capital and output coefficients among sectors are constrained to be the same for each component of investment. A unique constant term, however, is estimated for each sector. There are two advantages of the SUR approach. First, it allows the error terms of each equation to have a separate variance. Second, it allows the error terms of the equations to be contemporaneously correlated. In contrast, the panel models assume that the error terms for the different industries are drawn from the same distribution and are independent. It is quite likely, however, that the error terms are contemporaneously correlated due to unobserved shocks that affect structures and equipment investment of the same industry, or that effect investment in more than one industry. If these correlations are important, the SUR approach will be more efficient.

We estimate equation (3) for a data set consisting of the five major sectors for which cost of capital estimates and consistent investment data are available: 1) agriculture, forestry and fishing; 2) manufacturing; 3) construction; 4) retail and wholesale trade; and 5) transportation, communications and other utilities. A consistent investment series is available for Canada only until 1993, at which time changes were made in the organization of the data. Our sample period is therefore 1970-93. Two lags are employed for the cost of capital variable and four lags are employed for the output variable.[18] The data are discussed in detail in the appendix.

4.2 Results

The results are reported in Table 3 for machinery and equipment, and for structures. As seen in the table, the results are strongest for the machinery and equipment component of investment. The results for structures investment essentially indicate that relative changes in the cost of capital and GDP play very little role in determining relative investment rates in the two countries.

[18] Experiments with longer lags indicate that the coefficients on these longer lags become small in absolute value for both variables and actually positive for the cost-of-capital variable, in some cases.

Table 3
Results

	Mean-difference Estimation	First-difference Estimation	SUR Estimation
Machinery & Equipment			
Cost of Capital	-0.0332	-0.0356	-0.0284**
	(-1.731)	(-1.736)	(-3.7120)
GDP	0.3705*	0.3701*	0.3388**
	(2.2693)	(2.0194)	(3.6333)
Structures			
Cost of Capital	-0.0002	-0.0004	-0.0004
	(-0.1750)	(-0.3720)	(-0.8214)
GDP	0.1010	0.0406	0.0883
	(0.9612)	(0.3960)	(1.7212)

Coefficient estimates represent the sum of the coefficients on the lagged variables. Two lags are employed for the cost of capital, and four lags are employed for GDP. T-statistics are in parentheses.

* Statistically significant at the 5% level.
** Statistically significant at the 1% level.

Focusing on the machinery and equipment results, note that the coefficient estimates are very similar for all three models. The fact that they are similar for the mean-difference and first-difference approaches suggests the absence of serious measurement error. Importantly, the standard errors of the SUR estimates are much smaller than those for the other two models. As discussed above, this is as expected due to the efficiency gain of the SUR procedure when error terms across industries are contemporaneously correlated. Using a Breusch-Pagan test, the hypothesis that the error terms are uncorrelated can be rejected at the 1-percent level of significance.[19] The cost-of-capital coefficients suggest that the elasticity of the Canada/U.S. relative capital stock with respect to the relative cost of capital is approximately equal to 0.03. The estimates are statistically significant at the 1-percent and 10-percent levels for the SUR and panel models, respectively. In terms of the economic significance, these results imply that a 1-percent increase in the Canadian cost of capital would lead to a 0.03 percent decrease in the Canadian capital stock, holding constant the capital stock and cost of capital in the United States.

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[19] The χ^2 statistic is 110.88 with 45 degrees of freedom.

During the 1975-93 period, the average investment rate was 24 percent. Thus, a 0.03-percent decrease in the capital stock would require a 0.125-percent decrease in investment.

With respect to the GDP variable, the results indicate that relative changes in GDP have a more significant impact on relative investment rates, both economically and statistically. These results are generally consistent with previous studies based on highly aggregated data such as ours. In a survey of this literature, Chirinko (1993) concludes that the "response of investment to price variables tends to be small and unimportant relative to quantity variables."[20] The estimated elasticity of investment with respect to the user cost of capital has generally been less than 0.50 (in absolute value) and often close to zero. The relatively small elasticities with respect to the cost of capital, however, may merely reflect difficulties involved in using aggregate data to isolate the impact of the cost of capital rather than the actual absence of any effect.

Recent papers, based on more disaggregate data, find a stronger relationship between the user cost of capital and investment. For example, Chirinko and Meyer (1996) employ firm-level panel data to estimate elasticities of the capital stock with respect to the user cost of capital for 11 industry groups. The absolute values of their estimates range from 0.054 (the aerospace sector) to 1.664 (the information sector), and most are greater than 0.50. The authors caution, however, that their estimates are accompanied by relatively large standard errors and are therefore imprecise.

Another difficulty involved in identifying the impact of the cost of capital on investment is that investment decisions are based not only on the current cost of capital but also on its *expected* level in the future. To address this issue, Cummins, Hassett, and Hubbard (1994) take advantage of the natural experiments offered by U.S. tax reforms. Their approach is based on the idea that tax reforms represent discernible changes in expected tax rates. They find that, following each tax reform, the cross-sectional pattern of investment changed significantly and in a manner consistent with the tax changes. Cummins, Hassett, and Hubbard (1995) extend this analysis to

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[20] Chirinko (1993), page 1881.

examine tax reforms in 14 countries. They find evidence of significant investment responses for 12 of the 14 countries, including Canada.

In sum, our analysis should be viewed in light of the aggregate nature of the data set and the potential shortcomings of the simple neoclassical framework. Although we find a somewhat small relationship between the relative change in the user cost of capital and relative investment in machinery and equipment, the relationship is in the direction suggested by theory, statistically significant and consistent with the results of other studies. Our view is that the weight of recent evidence suggests that at least some of the differences in investment rates between the two countries can be explained by changes in the relative tax-adjusted cost of capital.

5. Conclusion

Two main conclusions can be drawn from this paper. First, the user cost of capital has generally been higher in Canada than in the United States throughout the period 1971-96. This is primarily due to higher real interest rates in Canada although the tax system has also contributed to Canada's higher cost of capital. Second, we find evidence that changes in the relative cost of capital have had an impact on relative investment levels in the two countries for equipment investment although not for structures investment. Although our estimated elasticities are relatively small, they are nonetheless statistically significant. Our view, based both on the analysis presented here and on recent work using more disaggregated data, is that at least some of the differences in investment rates between the two countries can be explained by changes in the relative tax-adjusted cost of capital. There is clearly, however, a need for more empirical work in a Canadian setting, particularly using disaggregated data.

Data Appendix

The Canadian investment data are drawn from the CANSIM database and are described in the Statistics Canada publications, Private and Public Investment in Canada, and Fixed Capital Flows and Stocks. The U.S. data were drawn from the Wealth Diskettes of the Bureau of Economic Analysis, U.S. Department of Commerce. Consistent series are available for Canada only until 1993, at which time changes were made in the organization of the data. Our sample period is therefore 1970-93.

The net-capital-stock series for both countries are based on the perpetual-inventory method using straight-line depreciation. The Canadian capital-stock estimates, however, are based on longer assumed service lives than the U.S. estimates. The longer service lives will tend to overstate the Canadian capital stock and therefore understate Canadian investment rates.[21] Nonetheless, Canadian investment rates have generally been higher than U.S. investment rates in all five sectors.

The output measure employed in the analysis of Section 4 is real sector-level GDP. The Canadian data were obtained from the CANSIM database and were compiled by the Input-Output division of Statistics Canada. The U.S. data were obtained from the Gross Product by Industry, 1947-93 diskette of the Bureau of Economic Analysis, U.S. Department of Commerce. For the United States, constant-dollar estimates are only available from 1977-93. For the earlier period, constant-dollar estimates were derived by deflating the current-dollar estimates by the GDP implicit price index obtained from the Survey of Current Business.[22]

Some of the key data used in the cost of capital calculations are summarized in Tables A.1 and A.2.

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[21] In addition, the Canadian capital-stock estimates are based on a "simultaneous exit" mortality function while the U.S. estimates are based on a bell-shaped mortality function. As discussed by the Organization for Economic Co-operation and Development (OECD) (1993), however, estimates based on the two mortality functions yield similar growth rates.

[22] The 1977 U.S. GDP estimates used for the calculated percentage changes in 1977 are based on the deflated current dollar 1977 estimates so that they are calculated in the same manner as the 1976 estimates. The constant dollar estimates of the BEA for 1977 are employed to calculate the 1978 changes.

Table A.1

Non-tax Parameters

	(1) q Canada	(2) q U.S.	(3) i Canada	(4) i U.S.	(5) π Canada	(6) π U.S.
1970	1.00	1.00	6.12%	6.44%	1.30%	5.29%
1971	1.01	1.01	3.62%	4.34%	5.14%	3.27%
1972	1.01	1.00	3.55%	4.07%	5.50%	3.65%
1973	1.00	0.98	5.39%	7.02%	9.28%	9.39%
1974	1.00	1.01	7.78%	7.87%	11.94%	11.80%
1975	1.01	1.06	7.37%	5.82%	9.48%	6.72%
1976	0.98	1.05	8.89%	5.00%	6.28%	5.22%
1977	0.98	1.05	7.35%	5.27%	8.96%	6.84%
1978	0.99	1.05	8.58%	7.22%	8.79%	9.28%
1979	0.97	1.05	11.57%	10.04%	9.62%	13.91%
1980	0.93	1.08	12.68%	11.61%	12.07%	11.83%
1981	0.91	1.04	17.78%	14.08%	11.33%	8.39%
1982	0.90	1.02	13.83%	10.89%	8.29%	3.71%
1983	0.86	1.05	9.32%	8.62%	5.34%	4.19%
1984	0.86	1.01	11.10%	9.57%	3.63%	3.53%
1985	0.87	0.99	9.46%	7.49%	4.46%	3.89%
1986	0.86	0.98	8.99%	5.97%	3.87%	1.46%
1987	0.83	0.96	8.17%	5.83%	4.11%	4.05%
1988	0.80	0.95	9.42%	6.67%	4.33%	4.67%
1989	0.78	0.93	12.02%	8.12%	5.50%	5.20%
1990	0.77	0.91	12.81%	7.51%	6.84%	5.65%
1991	0.72	0.88	8.83%	5.41%	1.60%	2.60%
1992	0.72	0.85	6.51%	3.46%	2.05%	3.26%
1993	0.73	0.81	4.93%	3.02%	1.31%	2.52%
1994	0.75	0.79	5.42%	4.27%	0.61%	2.80%
1995	0.75	0.78	6.98%	5.51%	1.59%	2.73%
1996	0.75	0.78	5.15%	4.96%	2.50%	2.50%

(1) Implicit price indexes for GDP and investment in fixed capital, Statistics Canada

(2) Statistical abstracts for the United States

(3) & (4) 3-month Treasury Bill rate, Statistics Canada (CANSIM)

(5) & (6) CPI indexes, Statistics Canada (CANSIM)

Table A.2

Tax Parameters

	(1) CIT Rate Canada-Man	(2) CIT Rate Canada-Gen	(3) CIT Rate U.S.	(4) PV TaxDepr Canada	(5) PV TaxDepr U.S.	(6) ITC Canada	(7) ITC U.S.
1970	53.41%	53.41%	51.57%	0.74	0.66	0.00%	0.00%
1971	51.06%	51.06%	51.57%	0.82	0.74	0.00%	7.00%
1972	48.50%	48.50%	51.57%	0.82	0.75	0.00%	7.00%
1973	42.00%	51.00%	51.57%	0.76	0.64	0.00%	7.00%
1974	42.00%	52.60%	51.57%	0.69	0.61	0.00%	10.00%
1975	42.00%	52.20%	51.57%	0.70	0.68	2.50%	10.00%
1976	42.00%	48.00%	51.57%	0.66	0.71	5.00%	10.00%
1977	42.00%	48.00%	51.57%	0.70	0.70	5.00%	10.00%
1978	43.00%	49.00%	49.71%	0.67	0.63	5.00%	10.00%
1979	43.00%	50.00%	49.71%	0.61	0.55	7.00%	10.00%
1980	44.50%	51.80%	49.71%	0.59	0.52	7.00%	10.00%
1981	44.50%	51.80%	49.71%	0.51	0.59	7.00%	8.00%
1982	44.50%	51.80%	49.71%	0.57	0.65	7.00%	8.00%
1983	44.75%	51.90%	49.71%	0.65	0.70	7.00%	8.00%
1984	44.00%	51.00%	49.71%	0.62	0.68	7.00%	8.00%
1985	44.00%	51.00%	49.71%	0.65	0.73	7.00%	8.00%
1986	46.00%	53.30%	44.12%	0.66	0.71	7.00%	0.00%
1987	43.30%	51.50%	38.53%	0.68	0.71	5.00%	0.00%
1988	41.34%	44.34%	38.53%	0.65	0.68	3.00%	0.00%
1989	40.34%	44.34%	38.53%	0.59	0.64	0.00%	0.00%
1990	39.34%	44.34%	38.53%	0.58	0.65	0.00%	0.00%
1991	38.34%	44.34%	38.53%	0.66	0.72	0.00%	0.00%
1992	38.34%	44.34%	38.53%	0.72	0.80	0.00%	0.00%
1993	36.34%	44.34%	38.53%	0.77	0.82	0.00%	0.00%
1994	35.34%	44.34%	38.53%	0.75	0.76	0.00%	0.00%
1995	35.62%	44.62%	38.53%	0.71	0.72	0.00%	0.00%
1996	35.62%	44.62%	39.47%	0.76	0.74	0.00%	0.00%

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Note: We would like to thank Duanjie Chen and Ying Kong for research assistance; and participants at the "Taxation, Business Investment and Employment" workshop, held in Toronto in March 1997, for helpful comments.

Technical Committee on Business Taxation

The Technical Committee was established by the Minister of Finance, at the time of the March 1996 federal budget, to consider ways of:

- improving the business tax system to promote job creation and economic growth,
- simplifying the taxation of businesses to facilitate compliance and administration, and
- enhancing fairness to ensure that all businesses share the cost of providing government services.

The Technical Committee will report before the end of 1997; consultations with the public will follow the release of the report.

The Technical Committee is composed of a panel with legal, accounting and economic expertise in the tax field. The members are:

Mr. Robert Brown
Price Waterhouse
Toronto, Ontario

Mr. James Cowan
Stewart McKelvey Stirling Scales
Halifax, Nova Scotia

Mr. Wilfrid Lefebvre
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Buchwald Asper Gallagher Henteleff
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The Technical Committee has commissioned a number of studies from outside experts to provide analysis of many of the issues being considered as part of its mandate. These studies are being released as working papers to make the analysis available for information and comment. The papers have received only limited evaluation; views expressed are those of the authors and do not necessarily reflect the views of the Technical Committee.

A list of completed research studies follows. They may be requested from:

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Technical Committee on Business Taxation Completed Research Studies

☐ **WORKING PAPER 96-1**
Comparison and Assessment of the Tax Treatment of Foreign-Source Income in Canada, Australia, France, Germany and the United States
Brian Arnold (Goodman Phillips & Vineberg)
Jinyan Li and *Daniel Sandler* (University of Western Ontario)

☐ **WORKING PAPER 96-2**
Why Tax Corporations?
Richard M. Bird (University of Toronto)

☐ **WORKING PAPER 96-3**
Tax Policy and Job Creation: Specific Employment Incentive Programs
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☐ **WORKING PAPER 96-4**
The Effects of Taxation on U.S. Multinationals and Their Canadian Affiliates
Jason G. Cummins (New York University)

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Michael P. Devereux (Keele University)

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Compliance Issues: Small Business and the Corporate Income Tax System
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